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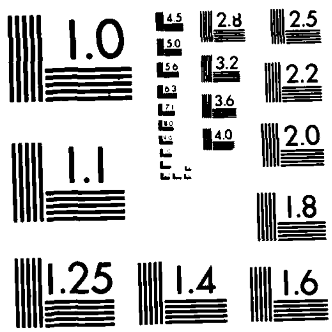

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HUMAN RESOURCE MODELS: AN OVERVIEW

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Bernard D. Rostker

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HUMAN RESOURCE MODELS
AN OVERVIEW

INTRODUCTION

A recent Secretary of the Navy frequently reminded his staff that "People are our most important resource." The subject of this chapter is how human resource models help the military departments manage their people so that the United States can meet its defense commitments.

The overview paper developed and illustrated some general principles about models and contrasted model types by specific area of application. This chapter illustrates the general principles by highlighting the different types of human resource models, and points out problems that model builders should consider when they the develop new models of this type..

In the next pages, we will consider: (1) the basic nature of human resource models and what sets them apart from the other models discussed in this volume; (2) a discussion of the various types of human resource models; and (3) a look at the future of human resource modeling.

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THE NATURE OF HUMAN RESOURCE MODELS

The reader will note that we use the term "human resource" rather than "manpower." In the military services, the terms "manpower," "personnel," "training," and "assignment" refer to systems that constitute separate organizational entities and management processes by which people are brought together with a weapon or support system in specific jobs to produce something called national defense. Though each system and the models that support it conceptually have their place in an integrated process of human resource management, little has been actually been done to develop the interactive models into a single human resource system. Following common usage, we will define the separate systems and later return to the notion of an integrated system for managing human resources. Usually, the system is viewed as:

- <u>Manpower</u>: the process of determining the numbers and types of people necessary to accomplish a given task.

- <u>Personnel</u>: the process of managing people, either directly by management action or indirectly through incentives that affect behavior, so that an appropriate type of person, as defined by the manpower process, is available to be "assigned" to a given unit.

- <u>Assignment</u>: the process by matching members of the available pool of [illegible] to specific jobs.

- o Training: the process by which a person who has specific skills or attributes is given a new set.

Human resource models--for instance, and personnel--are basically different from the combat models discussed in other chapters. Like logistics models, human resource models tend not to be built to support one-time policy decisions; rather, they have become integral parts of the process of managing human resources. For example, models are used to determine how many people will be recruited and promoted each month, how much they will be paid, and where they will be used. Unlike logistics models, the use of human resource models in personnel management is not new.* Moreover, human resource models focus on the resource that is hardest to model, control, or predict--people. This places special demands on the modeler, as we shall see.

All human resource modelers must determine (1) how to describe people and what type of aggregation scheme to use, and (2) how to take account of the fact that, unlike other resources, people learn and modify their behavior in response to changing both factors, exogenous and endogenous.

* A. P. Smith points out that, as early as 1679, the Secretary of the Admiralty regulated the annual entry of officers into the British Navy, and that by 1779, career structures, retention rates, and promotion probabilities were regularly analyzed for the Royal Marines. The systematic collection of the statistics used in personnel planning dates from 1820 in the British Navy, and the basic personnel planning models were discussed in 1899 in the Naval Proceeding of the American Navy. See, A.P. Smith, "Defense Manpower Studies," Operational Research Quarterly, Vol. 19, No. 3.

Aggregation

Any attempt to model a human resource process starts with a decision to describe people according to a well defined aggregation scheme. The basic building block in a military human resource model is the occupational classification structure. In the Army and Marine Corps, the building block is the Military Occupation Specialty (MOS); in the Air Force, the Air Force Specialty Code (AFSC); and in the Navy, a Rating. Regardless of nomenclature, each occupational classification system is an aggregation of tasks into jobs, jobs into positions, positions into occupations, occupations into career fields, and career fields into occupational groups. What should be noted is: (1) that each level is a somewhat arbitrary aggregation of an underlying structure, (2) that once a level of aggregation is chosen for a model, variations in the substructure must be ignored, and (3) that the usefulness of a model is directly related to the appropriateness of the aggregation scheme.

There are many examples of human resource models at each level of aggregation. The Services have incorporated data about individual tasks as part of the "Instructional Systems Development" process for designing new training programs. The President's Commission on Military Compensation (PCMC), by contrast, used models that aggregated military personnel into cells containing all officers and all enlisted personnel for each year-of-service; for example, all officers in a given year-of-service were assumed--regardless of their background--to react in the same way to given changes in retirement policy.

A faulty aggregation scheme may lead to unexpected results. The Air Force assumes that all journeyman avionics mechanics (AFSC 32672A) are homogeneous in their skills and "universally" assignable with equal effectiveness.to all models of the F-111, F-15, and F-16. There is some evidence that differences in the tasks that make up the specific jobs on the different aircraft make this assumption invalid.* The other Services make assignment on more specific classification structure which reflect training and experience on specific equipment. The Navy's Naval Enlisted Classification Code (NEC), for example, is used in conjunction with ratings to match people to specific jobs.

Behavior

The second problem that human resource modelers must face before they start building their models is how to account for people's ability to learn and change their behavior in response to factors incorporated in the model. Many human resource models use historical data on human responses deterministically, instead of re..izing that the observed responses represent patterns of behavior that will themselves change as endogenous factors in the model change.

This practice is illustrated by personnel planning models that use the transition probability obtained from historical records that an officer will move over time from the n^{th} year-of-service cell to the n+1 year-of-service cell. The model and the historic transition probability are

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* M.B. Carpenter-Huffman and B.D. Rostker, The Relevance of Training for the Maintenance of Advanced Avionics, R-1894-AF, December 1976, Rand Corporation.

used to explore the effect such policy changes as variations in promotion opportunities and tenure rules have on the officer profile. Yet the very act of changing the tenure rules or promotion opportunitites alters not only the policy parameters of the model, but also the underlying transitional probabilities.* Failure to account for human behavior compromises seriously the usefulness of the model.

HUMAN RESOURCE MODELS

Manpower Models

Manpower requirements models are designed to tell the human resource planner how many of what types of people are needed to produce given levels of output. Models range from large-scale simulation types to statistical models that show the numbers and types of people historically used to accomplish a measured amount of work. Simulation models tend to explore manning situations beyond the range of direct observation. By and large, industrial engineering approaches, which emphasize statistical analysis of workload and manpower actually

* A number of economists (Warner, McCall, and Gotz) have estimated the changes in transition probabilities as promotion policies are altered and then have incorporated these "behavioral" relationships into traditional models for personnel planning. See John Warner, Military Compensation and Retention: An Analysis of Alternative Models and a Simulation of a New Retention Model, RC-436), Center for Naval Analyses, Aug 1981, and Glenn Gotz and John J. McCall, Estimating Military Personnel Retention Rates: Theory an Statistical Method, R-2542-AF, Rand Corporation, Jun 1980.

employed, have gained broad acceptance as the prime tools for determining manpower requirements.*

Conceptually, simulation models provide many advantages over traditional industrial engineering approaches. The structure of this simulation model enabled researchers to develop manpower requirements as a function of such elements as flying schedule, component reliability, and frequency of repair and to relate manpower explicitly to projected system output, such as sorties flown and ship operations. Unfortunately, simulations are often limited by the poor quality of the basic data.** SAMSON, developed by the Rand Corporation, is one such case. By at least one account noted in 1968, the quality of data from the Air Force's AFM 66-1 system*** was so poor that it was unable to support the simulations. (Ten years later, when this author had occasion to try to use the same 66-1 data, inconsistencies and incompleteness of the same data frustrated the analysis.)

All too often, simulation models prove the adage, "garbage-in/garbage-out." The usefulness of a model may well be limited by inability to obtain reliable data with which to estimate its parameters. The analyst needs to give as much attention to the data he "feeds" his model as to

* See Richard J. Niehaus, Computer Assisted Human Resources Planning, (New York: John Wiley & Sons; 1979).

** For a comprehensive review of simulation models in which human performance plays an important part see, A.I. Siegel and J.J. Wolf, "Digital Behavioral Simulation--State-of-the-Art and Implications," Applied Psychological Services, Inc., Wayne, Pennsylvania, 1982.

*** Chauncy F. Bell, "SAMSON: A Logistics Simulation," in E.S.Quade and W.I. Boucher, eds., Systems Analysis and Policy Planning, (New York: American Elsevier Publishing COmpany, Inc., 1968).

the model itself. When someone offers a source of data which reportedly collects everything for all subjects, as the 66-1 data does for Air Force and 3M data for the Navy, a wise analyst will run and hide. In general, there is nothing so useless as an unreliable census. A carefully controlled and managed sample will almost always provide more reliable and usable information than an undisciplined census.

A more common approach to developing manpower requirements falls under the heading of industrial engineering. Commonly, multiple regression statistical techniques are used to establish the relationship between work performed/output produced and the observed level of employment. Data used in the statistical analysis reflect the observed variation in the output and employment levels across a given type of unit, or over time, or both. Here lies a major problem. Having a statistically derived manpower factor that relates, for example, engine overhauls to manpower required is of only limited use to manpower planners. Planners must also identify the factors that determine the number of overhauls that will be performed in a given period.

Attempts have been made to develop comprehensive planning systems for manpower requirements. The Navy's Manpower Mobilization System (NAMMOS) is a computer-assisted manpower system used by Navy planners and programmers to determine scenario-dependent requiement for mobilization manpower. Industrial engineering workload algorithms, however, account for only 54 percent of the Navy's mobilization manpower requirement. Fixed manning tables account for 28 percent of the manpower, with 18 percent of the total requirement related to policy judgment.

A serious problem with both simulation models and industrial engineering statistical relationships as tools for deterining manpower requirements is their general and often implicit assumption that the total manpower requirement is a direct function of the amount of work to be done, no consideration being given to the possibility of combining different types of labor to produce the same level of output at a different--and often lower--cost. Important questions of labor-labor substitutions are generally ignored.

An important application of economic research to questions of manpo requirements is use of the Constant Elasticity of Substitution (CES, production function and estimates of enlisted personnel productivit a number of military occupations. Specifically, recent studies show the possibilities of increasing productivity with different mixes of labor. In general, higher skill occupations tend to overutilize first-termers, and lower-skill occupations tend to unterutilize them. Moreover, though the present overall ratio of first-termers to career people falls within the range that would be selected on the basis of economic efficiency, the distributions within specific occupations are not.*

* See Mark J. Albrecht, Labor Substitution in the Military Environment: Implications for Enlisted Force Management, R-2330-MRAL, Nov 1979, Rand Corporation, and Glenn Gatz and C. Robert Roll, Defense Resource Management Study Supporting Papers: The First-Term Career Mix of Enlisted Military Personnel, Feb 1979.

Personnel Models

The traditional feature of military personnel systems is that it has an "in-at-the-bottom, up-through-the-ranks" structure. These systems are frequently modeled as a Markovian process, where movement through the system is determined by a set of transitional probabilities.* These probabilities are either explicit policies--only a specified percentage of a cohort will be allowed to pass to the next year--or averages of observed behavior over time. In general application today, personnel planners and managers use three kinds of models: steady state, dynamic, and transition.

The most common model is the static or steady-state model, in which the entire flow system is in equilibrium; i.e., the total number of people who enter the system is equal to the number who leave. Although such models help us understand the long-run effects of policy changes on personnel profiles, they do not show how today's personnel profile will look next year, if the transition probabilities are modified, directly by policy or indirectly through incentives and behavior.

* See Richard C. Grinold and Kneale T. Marshall, Manpower Planning Models, (New York: North Holland, 1977), and J.W. Merck and K. Hall, A Markovian Flow Model: The Analysis of Movement in Large-Scale (Military) Personnel Systems, Rand Corporation, R-514-PR, Feb 1971.

Dynamic model takes a given, non-equilibrium distribution of personnel and applies a Markovian process to obtain a new personnel profile for a specific period in the future. Thus, though the steady-state/equilibrium solution is not calendar specific, the results of a dynamic model do change from period to period.

In real-world applications, desirable steady-state policy solutions are often rejected when the near-term effects, as determined by applying the policies through a dynamic model, are shown to be unacceptable. An example is the analysis of alternative retirement systems developed by the President's Commission on Military Compensation. The steady-state analysis of alternative systems showed the benefits of proposed changes in the retirement rules. But, applying the new policies to the existing force, as was done in a dynamic analysis, reveled the magnitude of the increases in near-term costs associated with the proposals. The proposals were never adopted.

In recent years, transition models have gained in importance. The Army's ELIM-COMPLIP system and the Navy's ADSTAP program are such goal-linear programming models. They incorporate constraints and objective functions, such as manpower requirements and budget ceilings,* and are used to help formulate personnel policies and monitor progress against

* See A. Charnes and W.W. Cooper, Management Models and Industrial Application of Linear Programming, (New York: Wiley 1961).

goals, budgets, and force levels.* They are designed to describe the force structure that will come closest to satisfying a given set of manpower requirements given existing personnel constraints. Such applications are useful in the development of "optimal" combinations of policies that deal with a number of real-world constraints simultaneously.

Assignment Models

Manpower models are designed to help personnel planners determine the numbers and types of people needed to perform specific tasks. Personnel models are used to predict the likely outcomes of changes in a personnel policy. Assignment models, by contrast, are designed to match given individuals with given jobs in such a way as to maximize some objective function, subject to a set of constraints.

As used today, assignment models are employed in the initial classification and assignment process, as well as the reassignment of individuals. Examples of the former are the Air Force's PROMIS/PJM system, the Navy's PRIDE/CLASP system and the Army's REQUEST/PIM system. As structured, these models match men and jobs/school seats. They ofter consider the attributes of assignees, their preferences, and the goals of the Service.

* For a brief discussion of the use of ELIM, see: Betty W. Holtz and James M. Worth, "The Army's Approach to Improved Strength Forecasting," Defense Management Journal, Vol. 18, No. 2.

It should be noted that these matches are not optimal over time. A specific match depends on the time that an individual, billet, or school seat is entered into the model, as well as matches performed. The Army recently proposed a multiyear, multimillion-dollar program to expand the present personnel allocation/assignment system and develop a new one that will more than match recruits against the minimum eligibility requirements for job/school seats. Noting the sequential nature of the personnel process, the Army wants to expand its assignment models to be able also to look ahead and answer such questions as these: (a) What is the effect of filling a training seat with a minimally qualified volunteer? (b) What is the "cost" of deliberately leaving a training seat empty? and (c) What is the probability that a more qualified person will become available to fill some specific training seat in the next 24 hours somewhere in the U.S.?

A work of caution for those who develop assignment models: If such models are to be used, they must recognize that their subjects are human, not inanimate, and that people intervene in the assignment process. Many technically elegant models are never used because they are too mechanistic in their approach. Models can help in the assignment process. However, it is not realistic to believe that assignments can be made by computer without human intervention.

Training

The last human resource to consider is training. It can be argued that everything undertaken by the military in preparation for war is training. Though this is generally correct, distinguishing among types of training is useful:

- Formal training of individuals usually takes place in a dedicated schoolhouse setting, e.g., basic training and initial skill training.

- Unit/crew training sometimes takes place in established training environments but is also part of fleet and unit training exercises.

- On-the-job training is incidental to everyday work.

- Formal and informal skill progression training is among the requirements for promotion.

The magnitude and diversity of the Department of Defense's training suggest the potential range of models of various kinds. Manpower models help planners determine the numbers of instructors and support personnel needed to train a given number of personnel. Assignment models help make sure that people with a given set of attributes are assigned to specific courses of instruction. Scheduling models help insure the smooth flow of students through the "training pipeline." Simulation models have been developed to help course planners judge the effects of alternative course design, equipment levels, instructor manning, and student flow rates on the operation of the training system.*

Future Development of Human Resource Models

Earlier, human resource models were considered along the standard lines of manpower, personnel, assignment, and training. Future work will surely refine and extend models in each of these areas. The more innovative modelers, however, are increasingly aware that the functions and activities of the various organizations charged with managing human resources are intimately related. Decisions to change a training curriculum will result in changing work patterns and be reflected in changes in the statements of manpower requirements. Changes in retention patterns affect personnel policies, manpower requirements, and the ability of individual units to conduct on-the-job training.

Although every Service has combined manpower and personnel under a single Deputy Chief of Staff, little has been done to develop an integrated system. The existence of such tools as the CES production function and its lack of use by Service planners to explore alternative

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* Polly Carpenter-Huffman, "MODIA: Overview of a Tool for Planning the Use of Air Force Training Resources," R-1700-AF, Rand Corporation, Mar 1977.

manpower and personnel structures reflect the continuing fragmentation among the various human resource subsystems.*

A second factor a future model builder should consider is how his model will be used. In any year, many more human resource models are developed than are actually used by the Services in the planning or management of personnel. All too often, the modeler develops an elegant technical model, only to find that it is not relevant to the management process he was supposedly trying to affect.

The case of MODIA provides an important lesson. MODIA was designed to help Training Command personnel examine the details of course design and course operation during the planning stage of the process of instruction system development. Though MODIA was a technical success, it was never used by the Air Force. MODIA reflected the desire of the Air Force leadership to search out cost-effective alternatives. But, it was designed to be used at a local training center during the development of a curriculum. Unfortunately, no one--neither Air Force leadership nor MODIA's developers--asked whether those who were to use the new tool had any incentive to search out alternatives. A 1974 field test of MODIA

* A notable exception is the work by S. Craig Moore to describe and model basic interactions of the Air Force's manpower, personnel, and training systems. See Bruce Armstrong and S. Craig Moore, Air Force Manpower, Personnel, and Training: Roles and Interactions, R-2429-AF, Rand Corporation, June 1980, and B.E. Armstrong, S.W. Chapel and S.C. Moore, Air Force Manpower, Personnel, and Training System: Vol. II--Analysis of the Enlisted Authorization/Assignment and Manpower Requirements Personnel Objectives Subsystems, N-1476-AF, Rand Corporation, May 1980.

revealed that course planners did not operate in an environment of constrained resources and tended to game MODIA to justify the course designs they favored.

The Air Force leadership which commissioned MODIA and supported its development, never understood the incentive structure of those who would use it. The developers of MODIA did not understand how their model wouuld fit into the management structure of the Air Training Command. The question of implementation was addresed only <u>after</u> the model was developed. If adequate attention had been paid earlier, a different--and one hopes--more useful product might have been developed.

The experience of MODIA is a good way to end our discussion of hunman resource models. These models are generally used to manage people. Substantial bureaucratic structures have been built up to perform the personnel, manpower, training, and assignment functions. Models and modelers who support these organizations must not only be skilled technicians but must also understand how a specific model fits into the larger often implicit, human resource system and must be aware of the incentives of those who will use their models.

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